Human Factors in WAAS and LAAS

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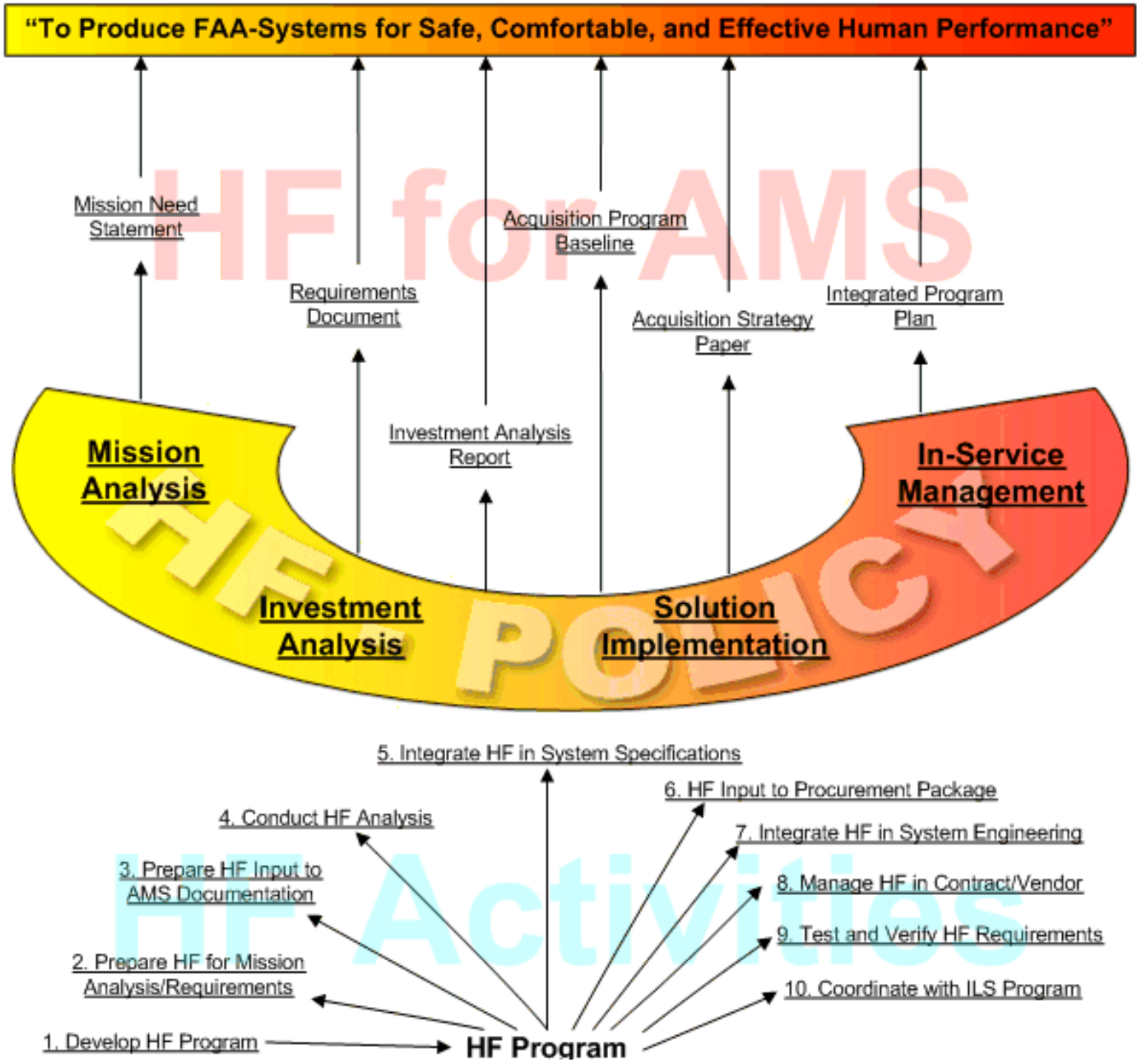
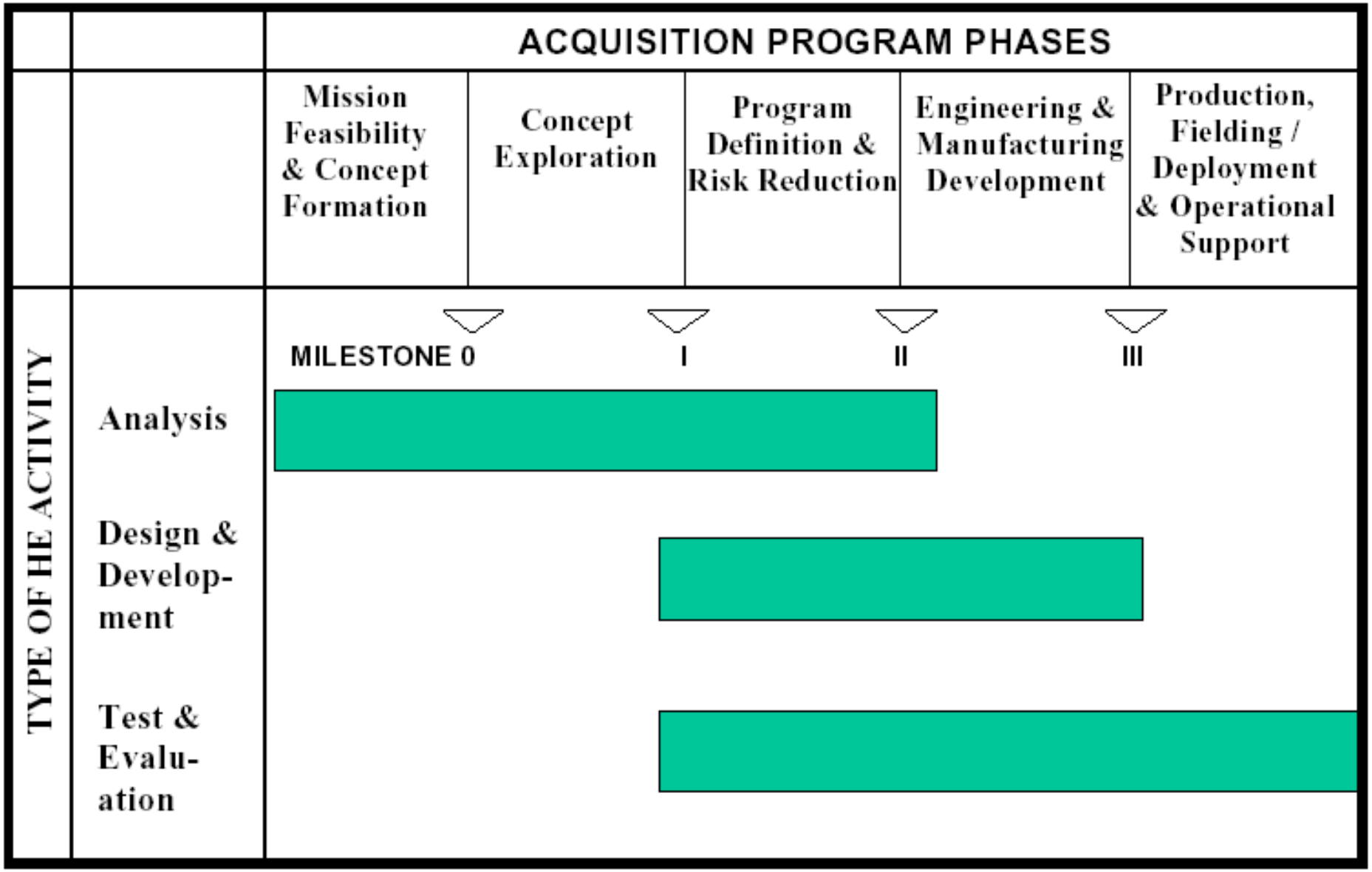
Human Engineering Process Standards

- MIL-HDBK 46855A – Human Engineering Program Process and Procedures
- Federal Aviation Administration – Human Factors Job Aid
- ANSI/AAMI HE74 2001 – Human Factors Design Process for Medical Devices
- Salvendy – Handbook of Human Factors and Ergonomics
- DEF STAN 00-25 Part 12 – Human Factors for Designers of Equipment: Systems

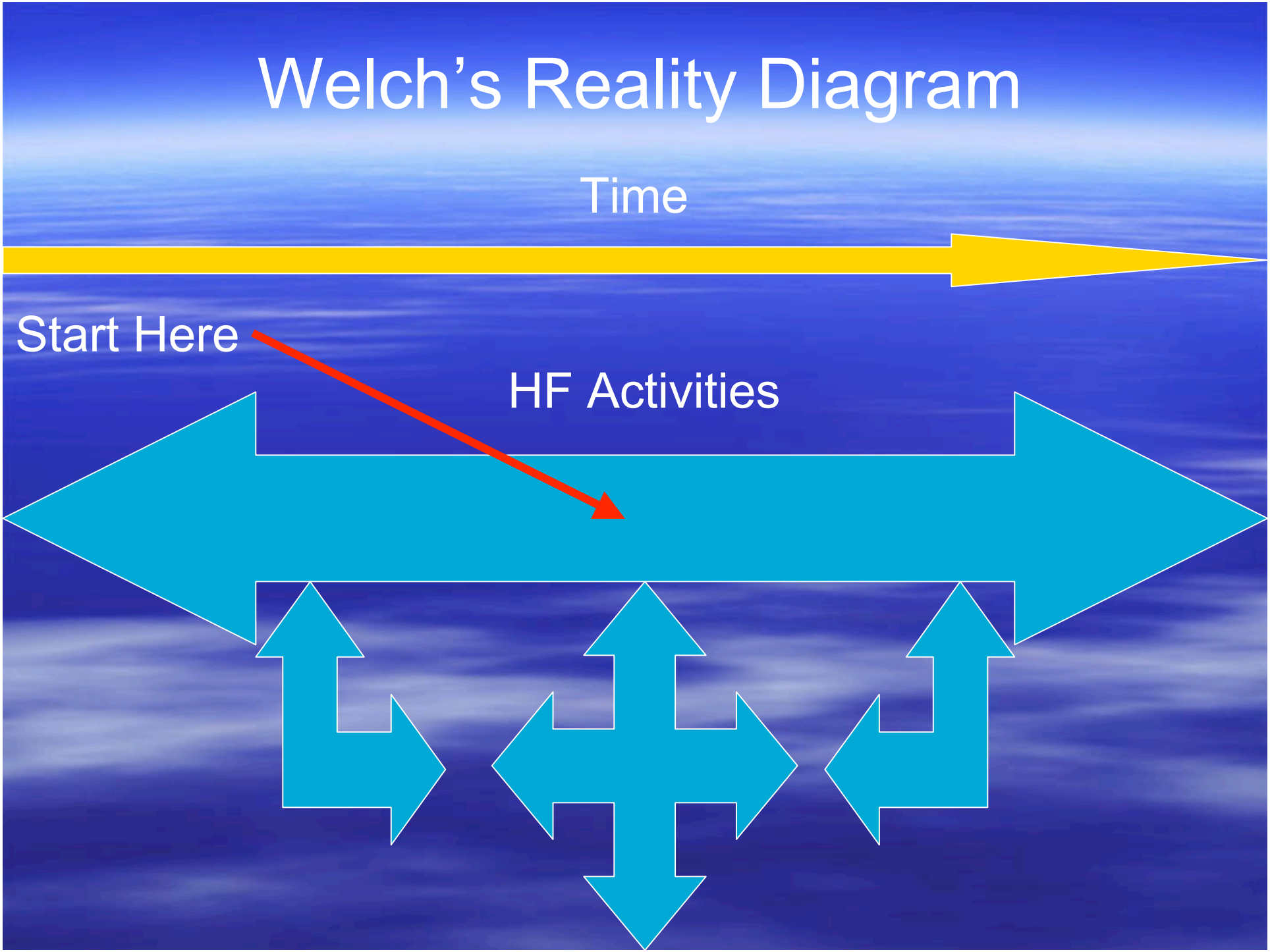

"To Produce FAA-Systems for Safe, Comfortable, and Effective Human Performance"
HF for AMS
Mission Need Statement
Requirements Document
Investment Analysis Report
Acquisition Program Baseline
Acquisition Strategy Paper
Integrated Program Plan
Mission Analysis
Investment Analysis
Solution Implementation
In-Service Management
HF POLICY
5. Integrate HF in System Specifications
6. HF Input to Procurement Package
4. Conduct HF Analysis
7. Integrate HF in System Engineering
3. Prepare HF Input to AMS Documentation
8. Manage HF in Contract/Vendor
HF Activities
9. Test and Verify HF Requirements
2. Prepare HF for Mission Analysis/Requirements
10. Coordinate with ILS Program
1. Develop HF Program
HF Program

MIL-HDBK-46855A



ACQUISITION PROGRAM & RESEARCH PHASES	CONCEPT EXPLORATION		PROGRAM DEFINITION & RISK REDUCTION	ENGINEERING & MANUFACTURING DEVELOPMENT	PRODUCTION/ DEPLOYMENT
	BASIC RESEARCH	APPLIED RESEARCH	ADVANCED TECHNOLOGY DEVELOPMENT	ENGINEERING DEVELOPMENT	OPERATIONAL SYSTEMS DEPLOYMENT
HUMAN ENGINEERING ACQUISITION FUNCTIONS	*Participate in:* Experiments, Concept exploration & COEA studies, Mockups, Models, System analyses, Task & workload analyses, Function allocation studies Input to MNS, ORD		Task & workload analyses, Function allocation studies, Design, models & mockups, Prototypes, Demonstrations, Procedures, IPTs	Evaluate detailed designs, Changes to baseline, Operability, Maintainability, Developmental T&E, Demos, Procedures, IPTs, Design revs.	Conduct OT&E, Evaluate ECPs, Modifications
HUMAN ENGINEERING INTERFACES WITH RELATED DISCIPLINES	Biomedicine & life support MPT Maintainability Reliability Safety Health hazard assessment Survivability Systems engineering Logistics support		Biomedicine & life sup. MPT Maintainability Systems engineering ISD/training system design Life-cycle cost estimates Health hazard & safety Survivability	Biomedicine & life sup. Logistics & MPT Publication & manuals Maintainability Health, safety, reliability ISD/training systems Life-cycle costs Developmental T&E	Biomedicine & life support Publications & manuals Maintainability Health, safety MPT ISD/training sys Operational T&E
OBJECTIVES	**TECHNOLOGY RESEARCH**	**PAPER STUDIES**	**CRITICAL ISSUES EVALUATION**	**ENGINEER EVALUATION DT&E AND OT&E**	**OPERATIONAL HARDWARE**
DoD PROGRAM MILESTONES	0	I	II	III	
Approval of:	Mission need and initiation of conceptual studies	Initiation of new acquisition program	Engineering & Manufacturing Development & Low Rate Initial Production	Production, Fielding or Deployment	

Welch's Reality Diagram

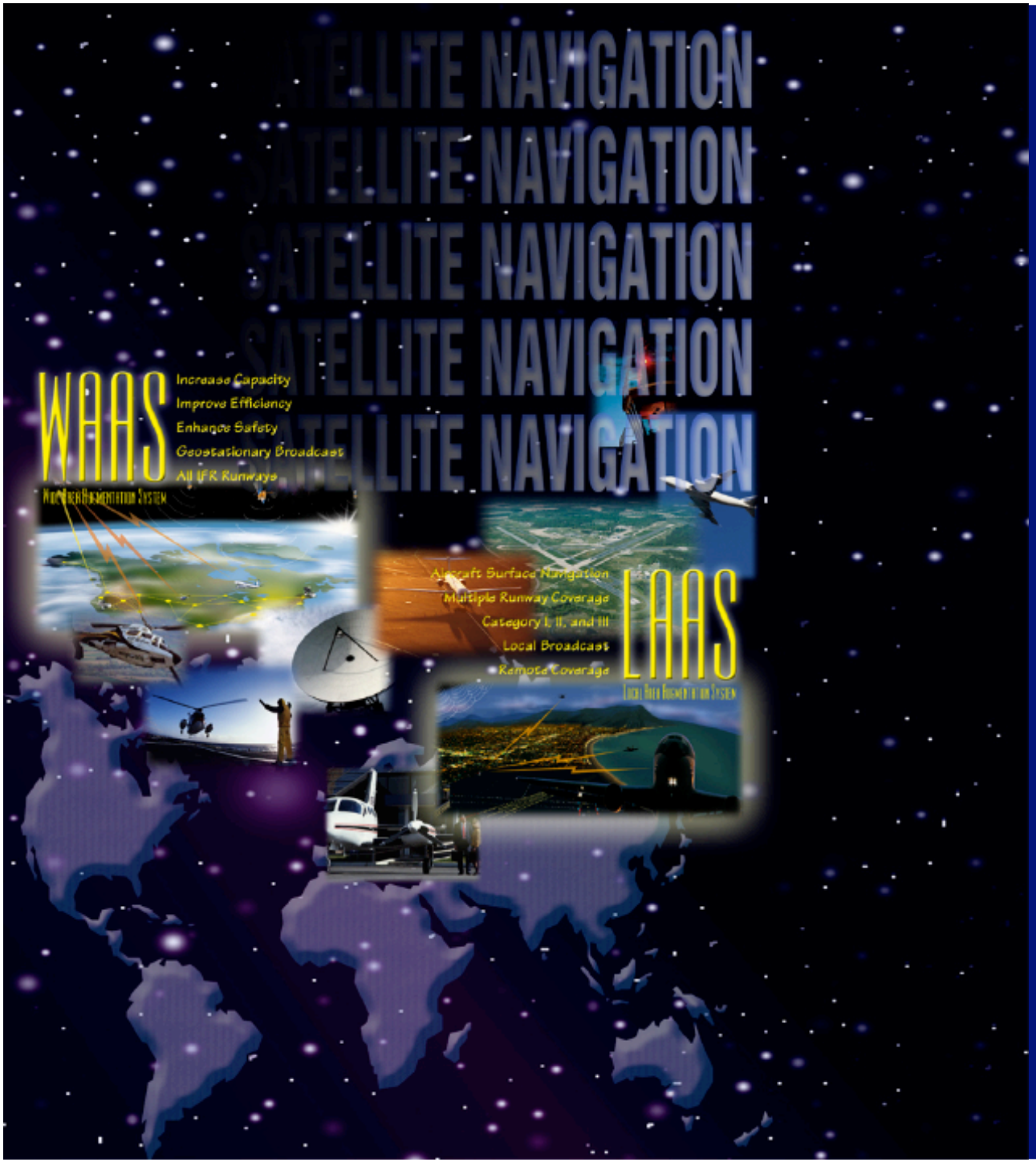


Ergo . . .

SE / HE Integration Processes give us a *general approach* to our tasks,

But

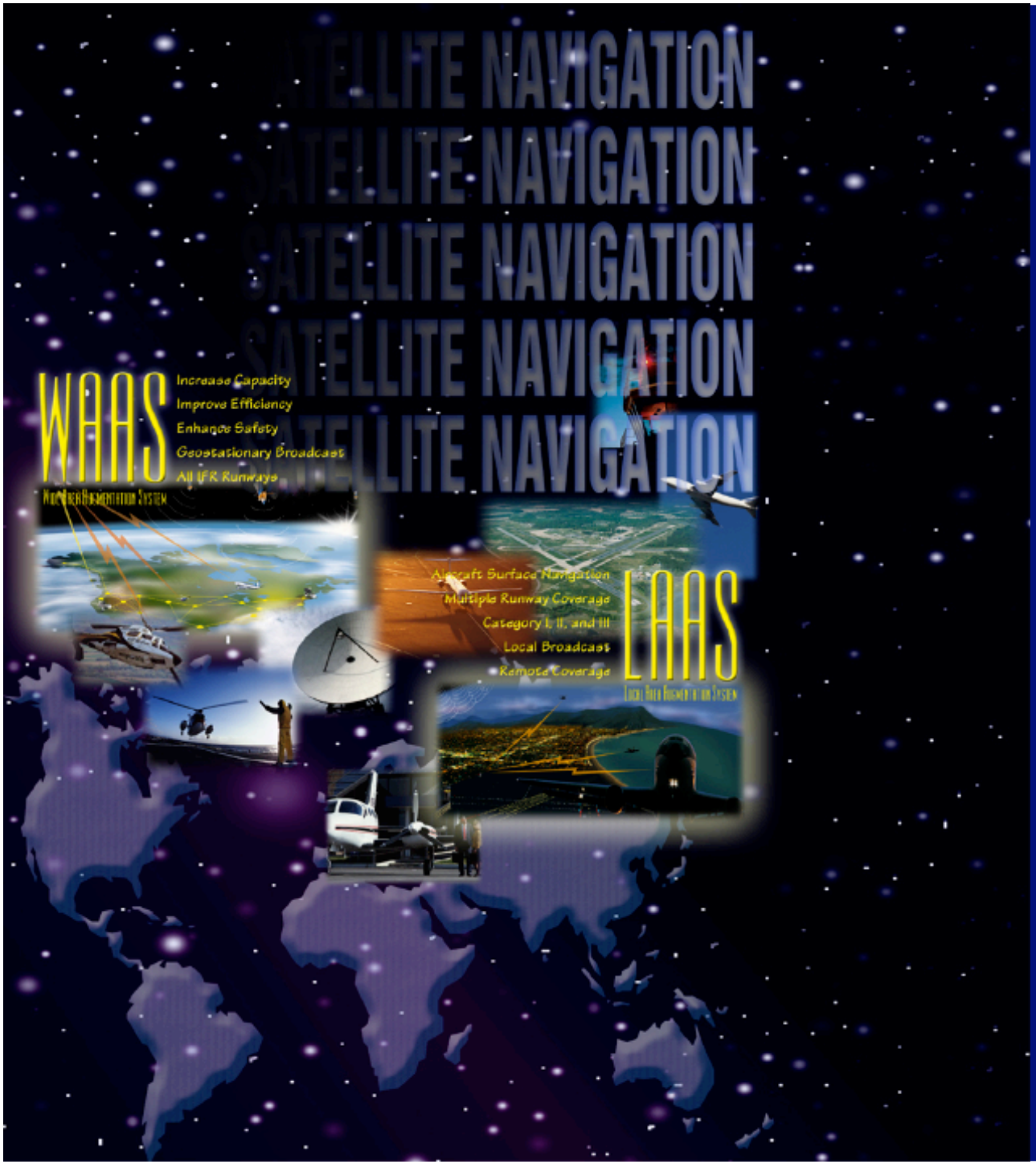
They can't be dogmatically followed in the *specific case*.



Two Specific Cases

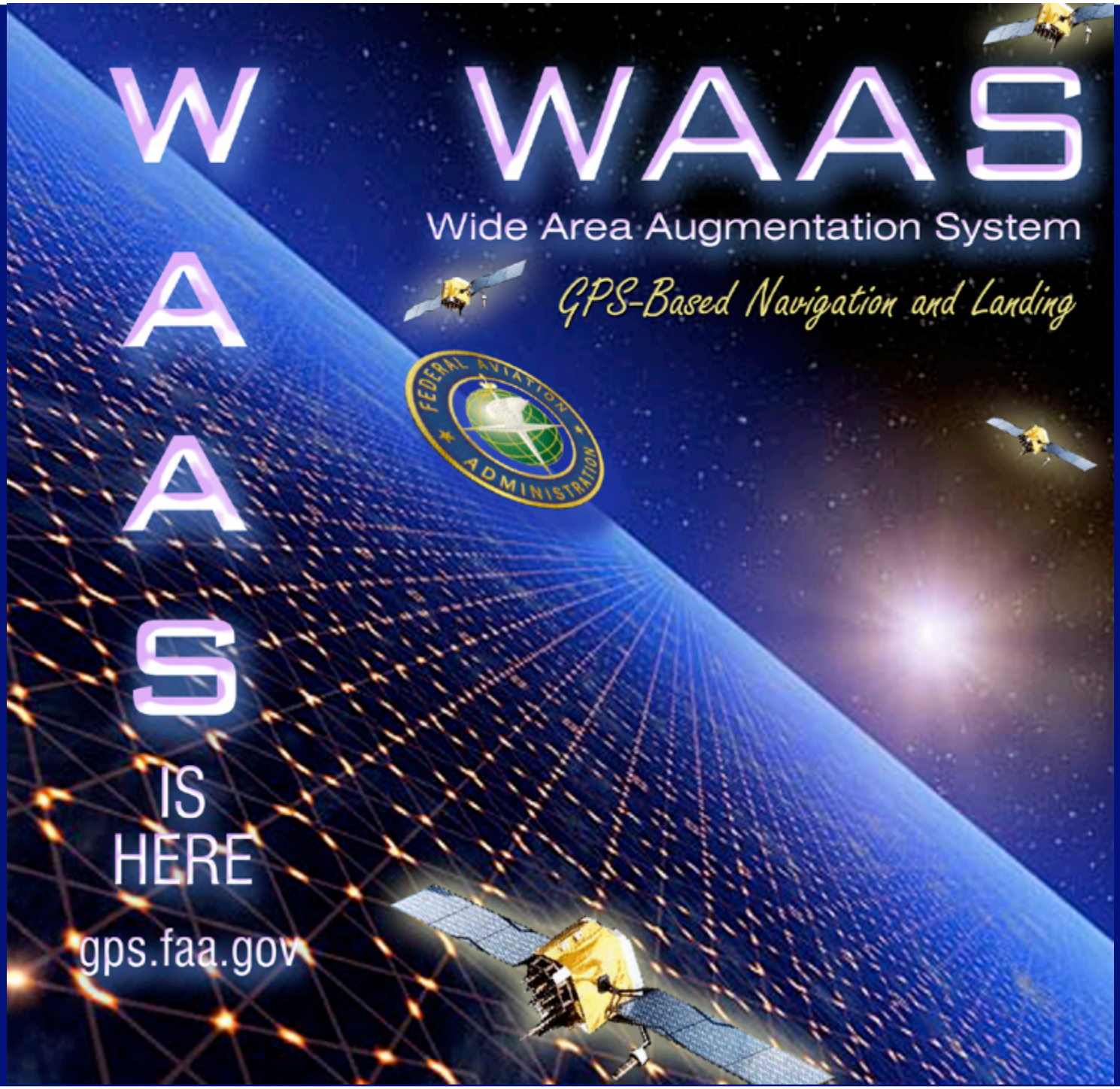
Wide Area Augmentation System

Local Area Augmentation System



Two Specific Cases

The Impact of Differing Acquisition Realities on the Human Factors Tasks, Tools, and Procedures Employed in the Acquisition Efforts


WAAS
Wide Area Augmentation System
GPS-Based Navigation and Landing
FEDERAL AVIATION ADMINISTRATION
W
A
A
S
IS
HERE
gps.faa.gov

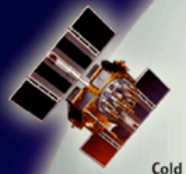
2 Wide-area Master Station

25 Wide-area Reference Station

3 Ground Earth Station

2 O&M Console

24 GPS Satellite



2 GEO Satellite

WAAS O&M Console @ NOCC

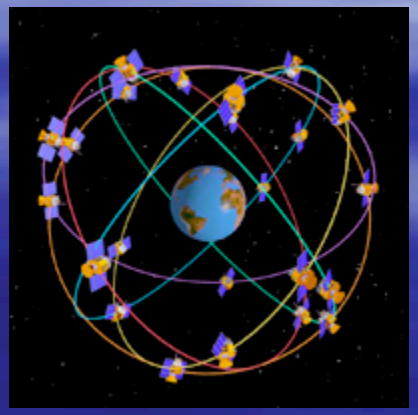
WAAS Contract History

- August 1995 – Wilcox Electric Inc.
- April 1996 – Contract Terminated
- May 1996 – Hughes Aircraft Co.
  (Raytheon Co.)
- June 1999 – Contract Rebaselined
- January 2000 – WAAS Integrity Perf. Panel
- August 2000 – WAAS Review Board
- November 2001 – Contract Rebaselined
- 2004 – Contract Rebaselined

Impact on HF

"During this entire period the WAAS program experienced a number of contractor, scheduling, funding profile, and operations and maintenance concept difficulties.

Individually and collectively, these difficulties negatively impacted HF efforts and participation in system design."



Impact on HF

- Initially Wilcox had a full-up HF program
- HF de-emphasized at contract termination
  (Due to life-cycle contractor O&M support)
- HF “on back-burner” August 2001
  (To concentrate on safety & integrity issues)
- WAAS commissioned July 2003
  (O&M by FAA vs. contractor)
- IOC to FOC Transition (Sep 04)
  (HW & SW improvements)

Impacts on WAAS HF

- Contract history
- Safety and integrity problems
- Support concept changes
- Congressional and airline pressure
- Conscious decisions vs. “bad blood,” lack of concern, misunderstanding HF

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Little WAAS HF Accomplished

Current HF Efforts

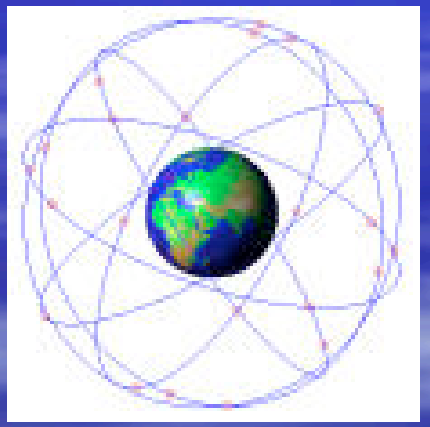
- WAAS, as it exists today, contains a number of HF issues which need to be addressed
- HF for WAAS now consists of identifying and correcting those issues vs. “designing them out”
- Much like US nuclear industry post-TMI
- HF is an exercise in change control.

WAAS HFE Tasks

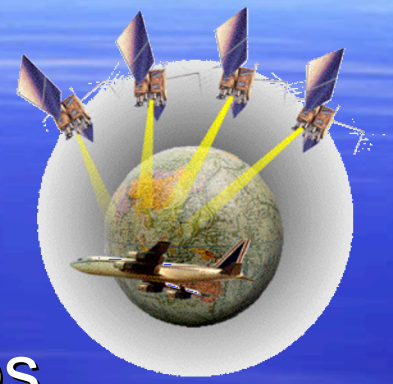
- Initial Analyses

(Should Have Been Done Long Ago)

  - Task Inventories
  - Criticality Analysis
  - Critical Task Analysis
  - Critical Design Considerations



WAAS HFE Tasks



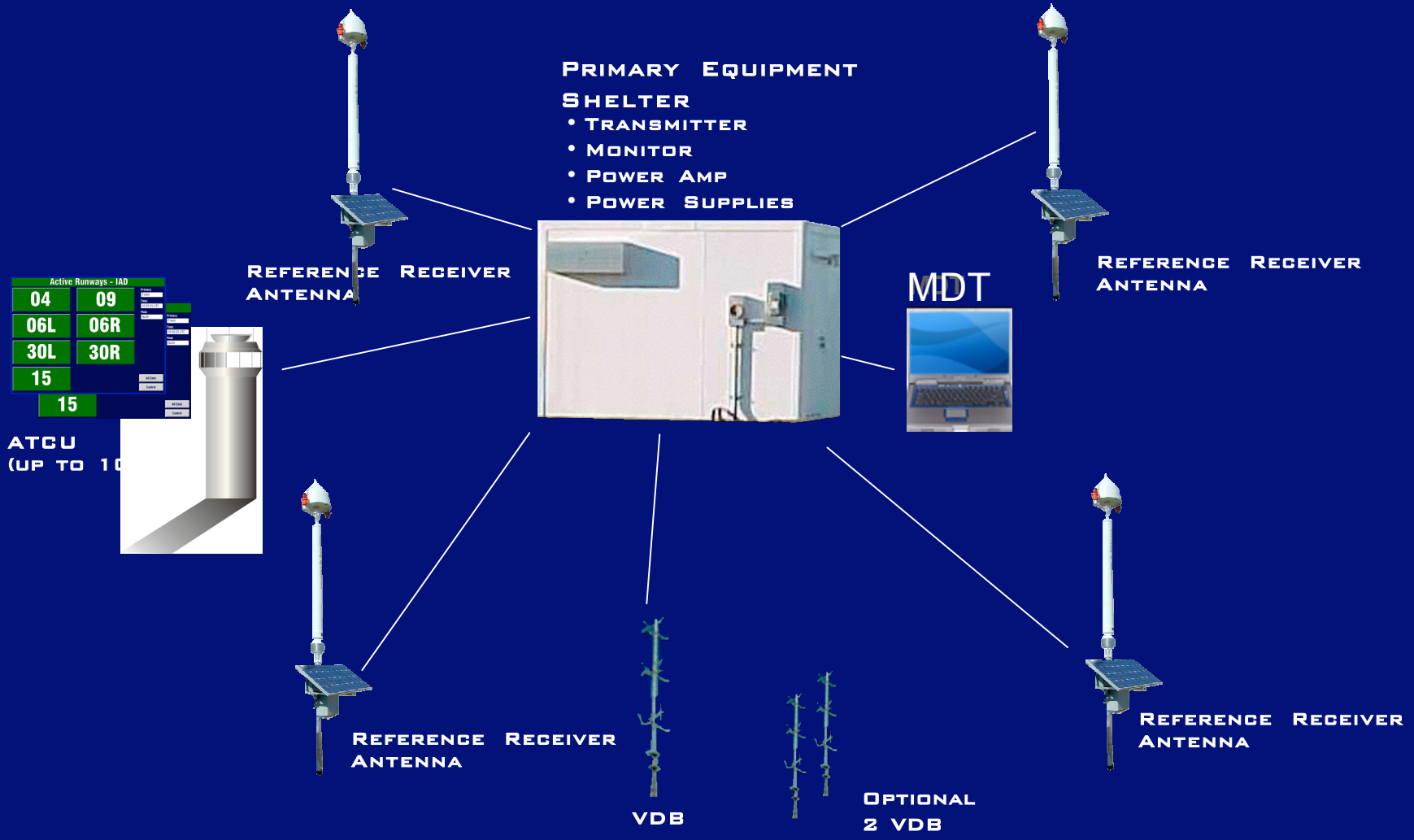
- Problem Identification & WHAIL
  - Mockups, Prototypes, Simulations
  - Operators & Maintainers Users Groups
- Solution Development
  - Users Groups
  - HF Working Group
- Solution Implementation (WCCB) & Tracking
- Change Control Monitoring

WAAS Summary

- Problems in the Contracts World Led To Problems with HF
- HF “Shut Off” While System Developed
- Retrofit HF Improvements to Existing WAAS


FEDERAL AVIATION ADMINISTRATION
LAAS
Local Area Augmentation System

LAAS Configuration

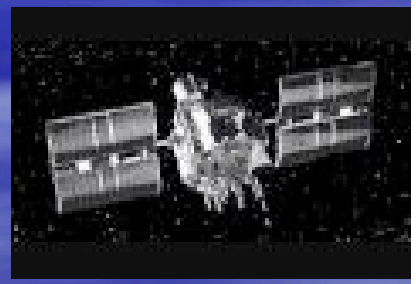


Contract History

- April 1997 – Formation of GIPs
  - CAT I LAAS – Type Acceptance/Certification
- April 2002 – RFO for Full-Up LAAS Development Program to CAT II / III
- June 2002 – Acquisition Strategy Changed to a Phased Development
  - Phase I – CAT I Design to CDR
  - Phase II – LRIP at 6 Operational Sites
  - Phase III – CAT II / III Development and Approaches at Additional Sites

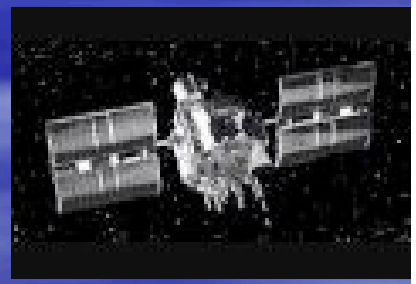
Contract History

- Leverage GIP Efforts and Results to Phase-In CAT I LAAS, Then Transition to CAT II / III
- April 2003 – Contract Award to Honeywell
- Jan 2004 – Integrity Problems and Concentration on Integrity Issues
- Feb 2004 – HF Activities Shut Down
- Mar 2004 – Program De-Scoped
  - Integrity Design Only – LAAS Integrity Panel (LIP)



Contract History

- Oct 2004 – 3-Phase Effort
  - Phase 1 – 3 Honeywell Beta-LAASs to Micronesia
  - Phase 2 – Merge Beta-LAAS with Integrity Panel Work
  - Phase 3 – Category II / III Development



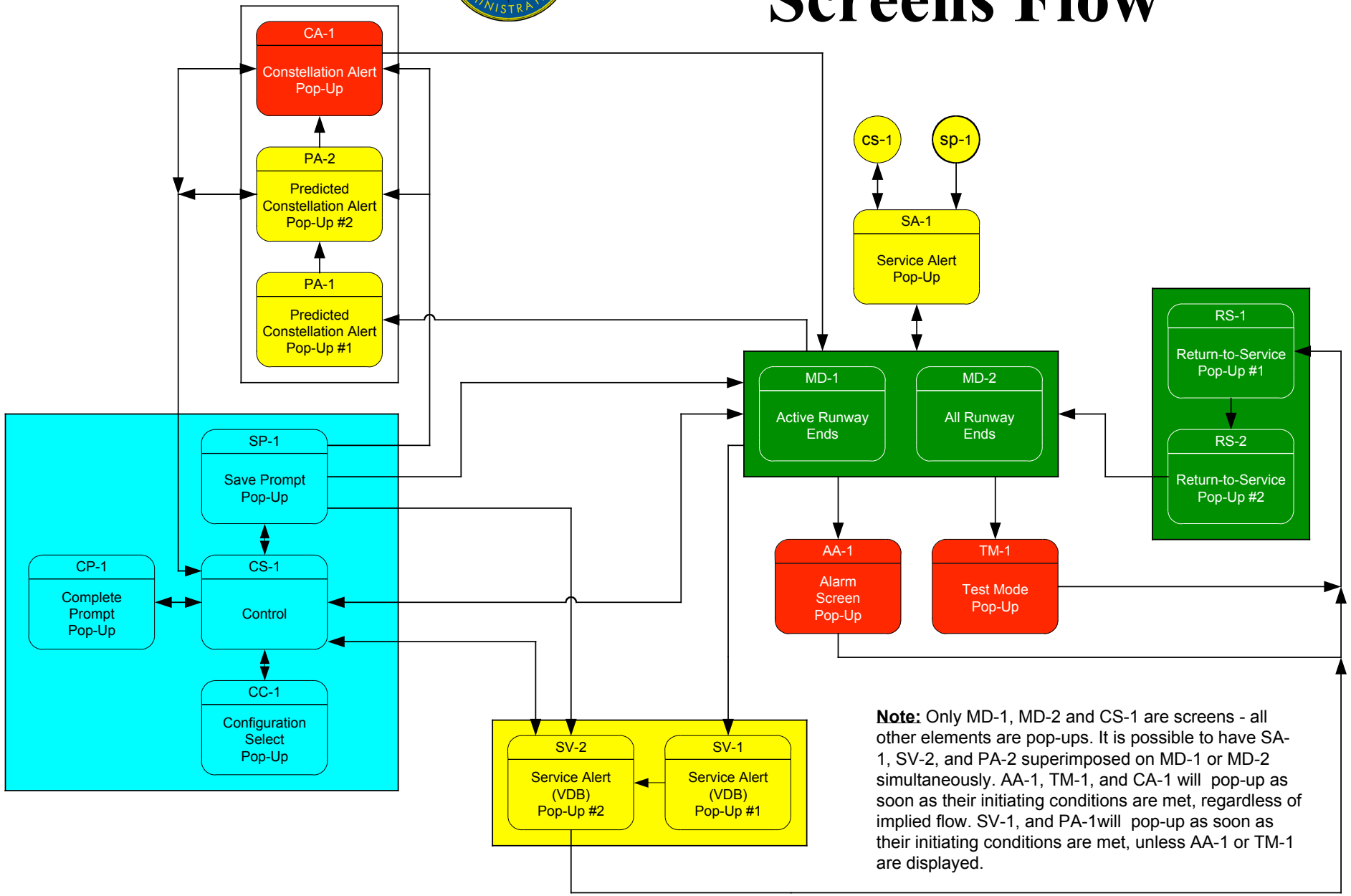
Initial HFE Activity

- GIP
  - Prototype MDT & ATCU Demonstrations
  - Evaluated Against Exit Criteria
    - HFDG not Process
- Development Contract
  - Acquisition Documentation & Proposal Evaluation

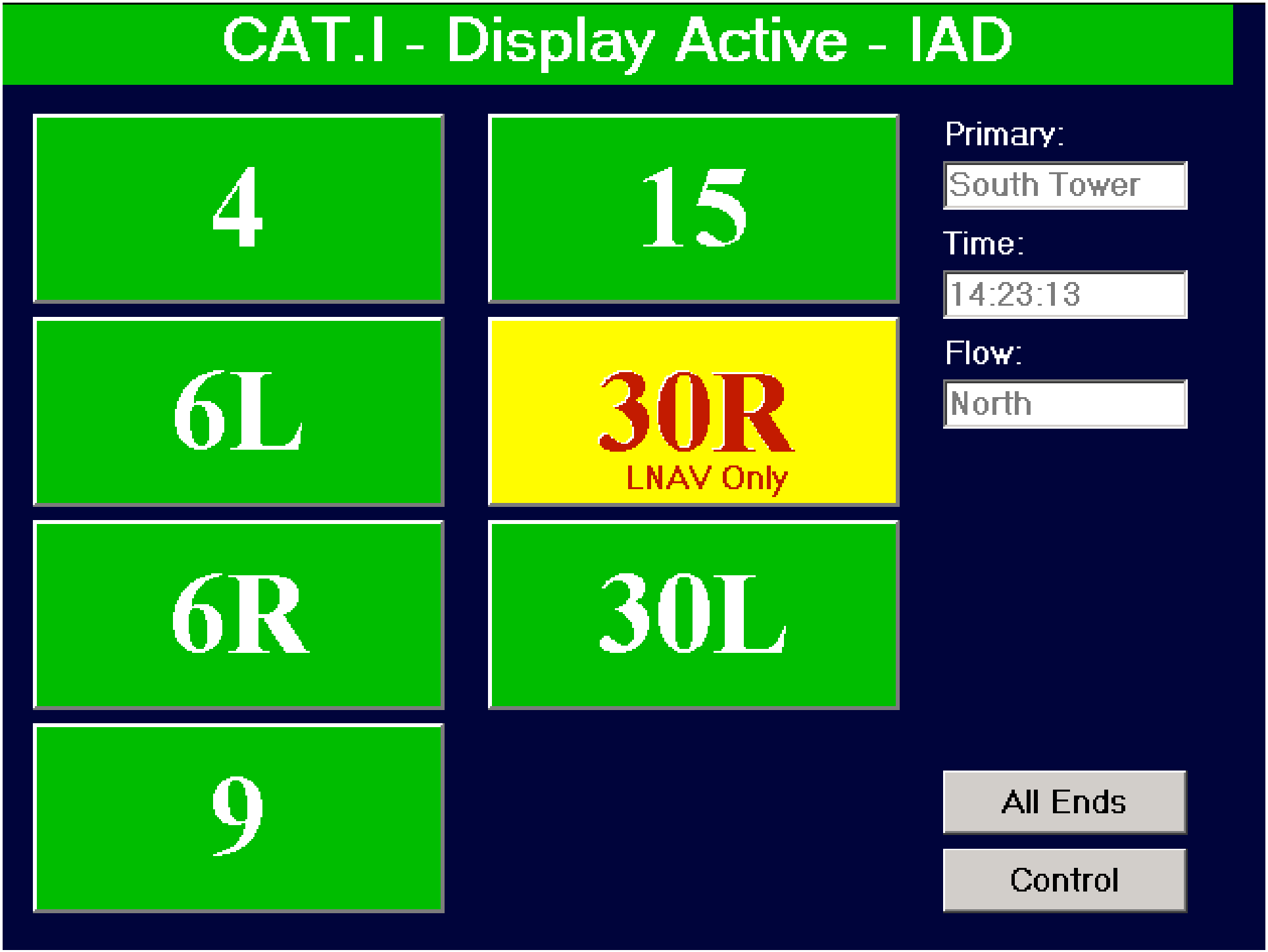
Contract HFE Activity

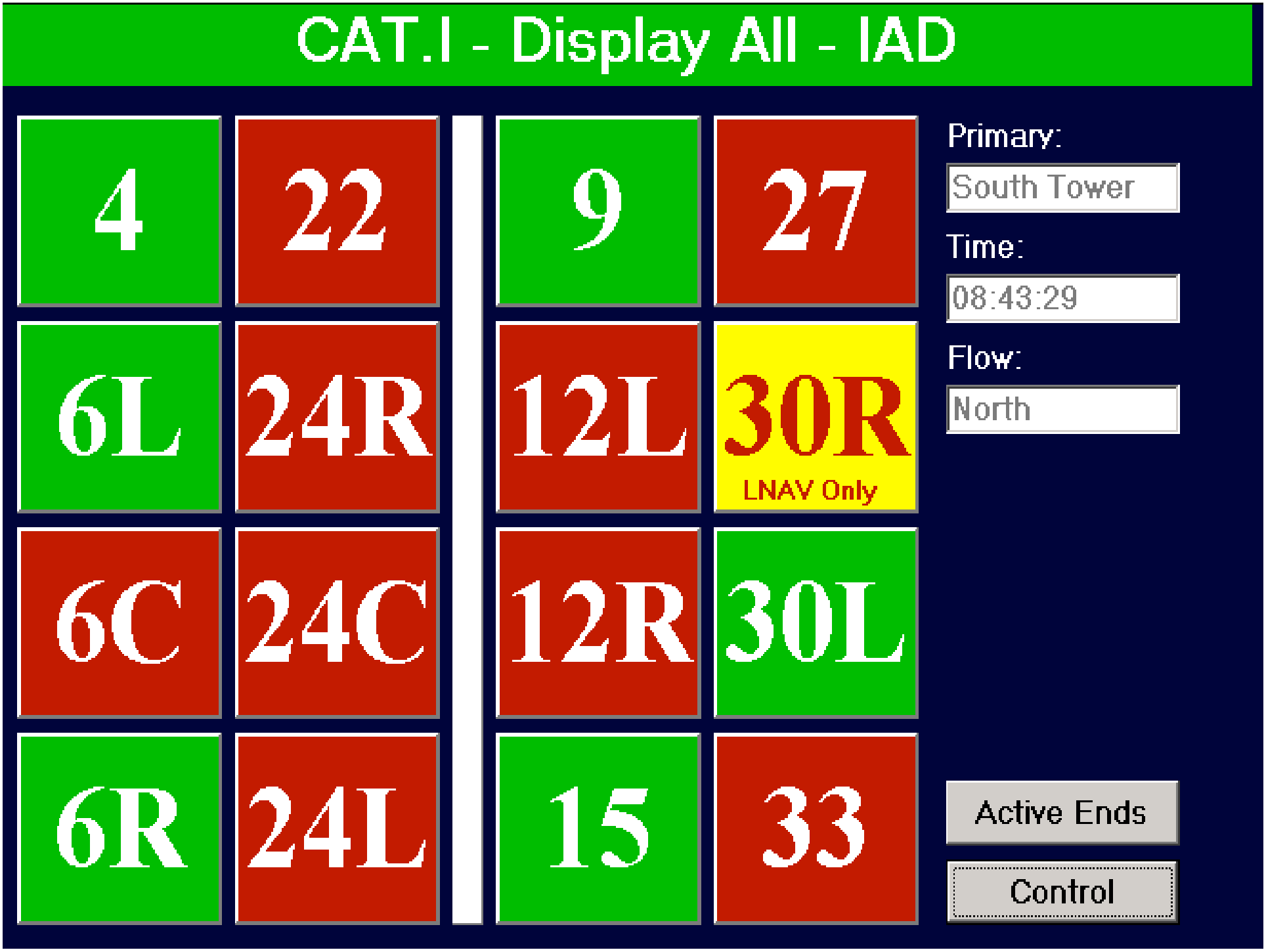
- Phase I Acquisition -- Conventional HF Program
  - System Analysis (FFDs)
  - Task Inventory
  - Criticality Analysis
  - CTA & CDC Development
  - User Groups
  - Working Groups
  - ATCU User Interface Development & Testing

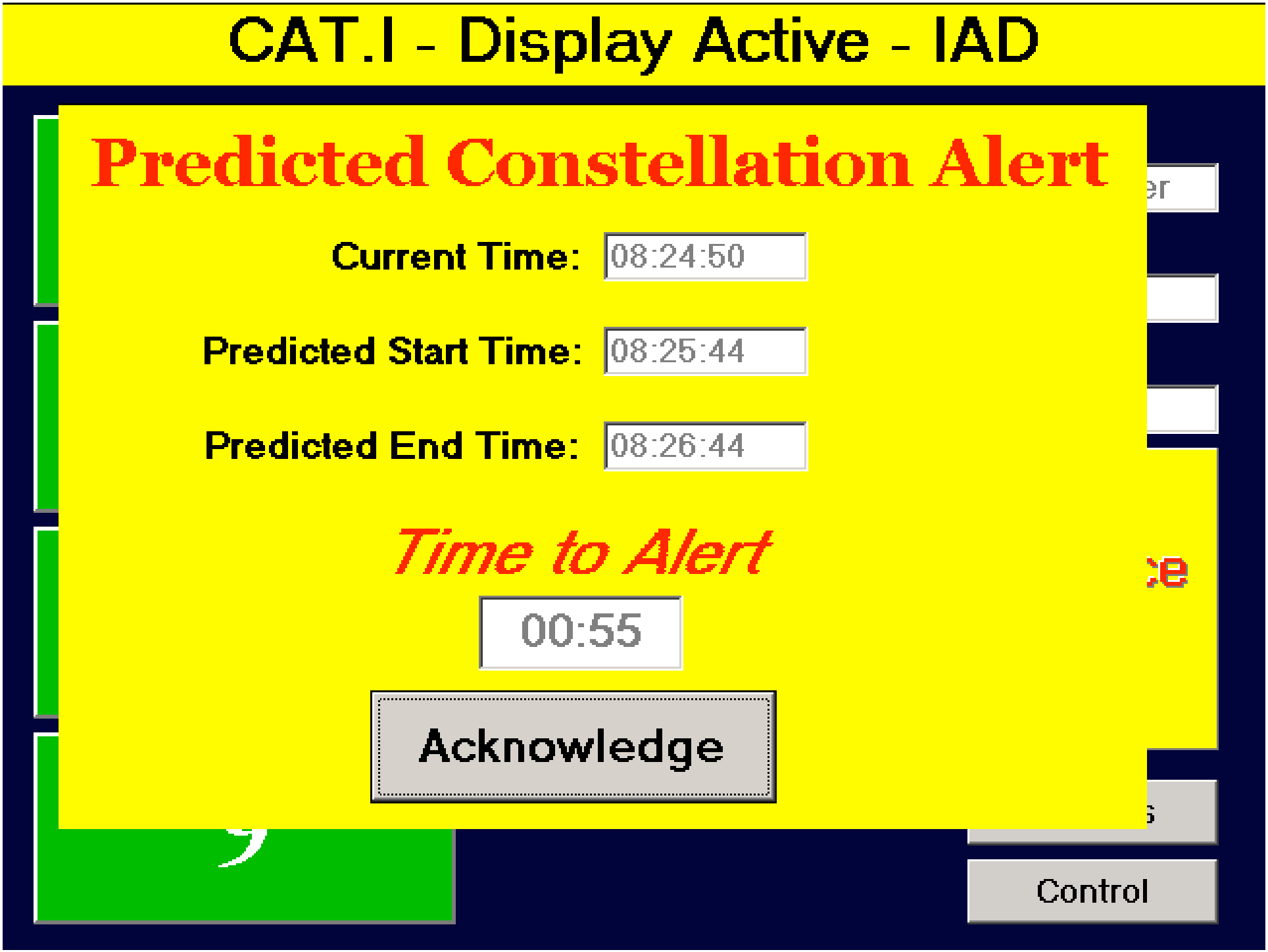
ATCU Concept Interface Screens Flow



Note: Only MD-1, MD-2 and CS-1 are screens - all other elements are pop-ups. It is possible to have SA-1, SV-2, and PA-2 superimposed on MD-1 or MD-2 simultaneously. AA-1, TM-1, and CA-1 will pop-up as soon as their initiating conditions are met, regardless of implied flow. SV-1, and PA-1will pop-up as soon as their initiating conditions are met, unless AA-1 or TM-1 are displayed.


CAT.I - Display Active - IAD
4
15
6L
30R
LNAV Only
6R
30L
9
Primary:
South Tower
Time:
14:23:13
Flow:
North
All Ends
Control


CAT.I - Display All - IAD
4
22
9
27
6L
24R
12L
30R
LNAV Only
6C
24C
12R
30L
6R
24L
15
33
Primary:
South Tower
Time:
08:43:29
Flow:
North
Active Ends
Control


CAT.I - Display Active - IAD
Predicted Constellation Alert
Current Time:
08:24:50
Predicted Start Time:
08:25:44
Predicted End Time:
08:26:44
Time to Alert
00:55
Acknowledge
Control

ATCU User Testing

- 4 Nationwide ATCs
- Lab Testing
  - 21 Task Scenarios
  - 1 End State Error (Inconsequential)
- Focus Group Discussion
  - User Acceptance with 13 Recommendations
  - 8 Unresolved Issues

Contract HFE Activity

- Phase I Acquisition -- Conventional HF Program
  - System Analysis (FFDs)
  - Task Inventory
  - Criticality Analysis
  - CTA & CDC Development
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  - Working Groups
  - ATCU User Interface Development & Testing

Feb / Mar 2004
Drop Back 10 and Punt

- Integrity Only
- “Fluid Requirements” -- ATCU
  - No Additional Glass in Tower
- Maintenance Monitoring Concept
  - NIMS
  - Alerting Techniques – Remote Status Panel

ATCU Glass in Tower

- No New Glass In Tower
- Potential Solutions
  - Integrate with Existing System
    - No Existing System Meets New Security Reqs.
  - Develop New Display and Include NAV Systems
    - What Systems?
    - Who Pays
- Revisit ACTU Requirements

Maintenance Monitoring

- NIMS
  - Does Not Currently Exist
  - May Not Exist For Some Time

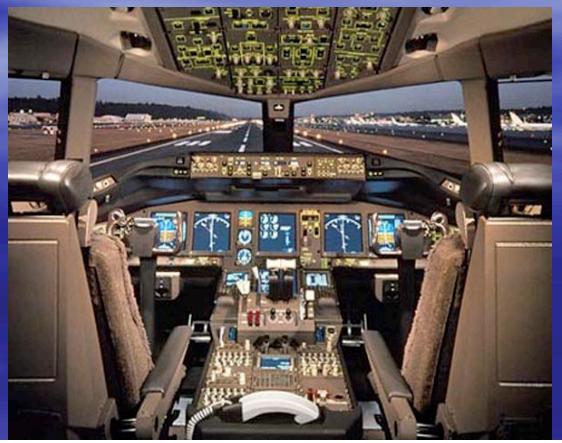
- Currently an Un-Manned System
  - Alert at ATCU?
  - Pilot First to Know
- Alerting Techniques
  - Remote Status Panels

Impact on LAAS HFE

- Post-GIP, Traditional Development Attempted
- Realities Outside of the Program Office
- Changing Requirements
- Currently System Development Without HF → Following WAAS's Lead
- Deal with 2 "System" Issues
- No HW / SW Design Until Program Re-Starts

LAAS Summary

- Nice Try, But No Cigar
- Put Out HF Fires
- Attempt to Re-Start “Traditional” Development
- Not Holding Our Breath

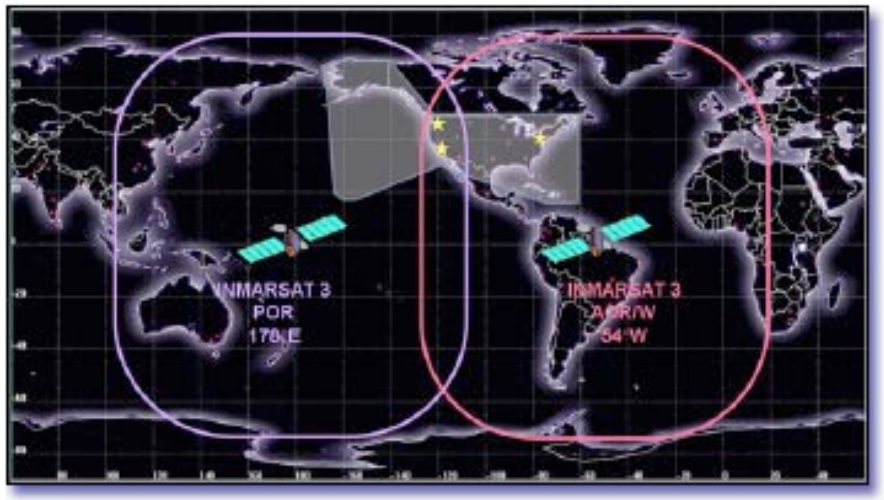


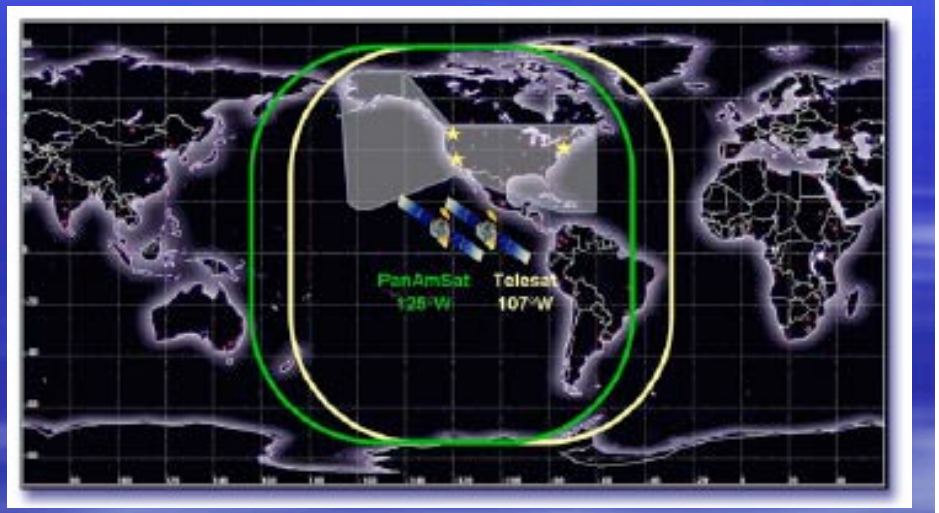
Conclusion

- Texts books, graduate courses and academic papers provide a theoretical ideal of how HFE should be integrated into the system engineering process.
- HF practitioners know it never happens that way.
- The reality is that forces outside of our control constantly impact what we do, how and when we do it, and most importantly, why we do it.

Conclusion

We Have to Roll with the Flow


INMARSAT 3
POR
178°E
INMARSAT 3
AMR/W
54°W


PanAmSat
125°W
Telesat
107°W

Wide Area Augmentation System

LAAS

Local Area Augmentation System

FAA Wide Area Augmentation System